full of suggestive ideas and again calls to mind the loss that geology has sustained in the untimely death of J. B. Hatcher. Had he lived he would have continued to make important contributions to the geologic history of the West, especially in connection with the problems concerning the non-marine formations whose importance he fully recognized and in which he was so deeply interested.

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THE MORPHOLOGICAL SUPERIORITY OF THE FEMALE SEX.

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It is remarkable the view should still generally obtain that the male sex is superior structurally to the female. This has resulted mainly from the fact that most writers upon sexual dimorphism have been males and, on the principle that charity begins at home, wished to give their sex all credit. Social economists in their ill-considered gleanings from Biology hold for the most part that the male is the superior, structurally and psychically, speaking of man as the "progressive" and woman as the "conservative" element of human society. But even if these terms are correctly applied, which is assuredly open to question, it does not follow that conservatism denotes inferiority and progressiveness superiority, at least from the morphological standpoint. Some naturalists share this opinion, though the facts are in patent contradiction to it; others grant the female is the superior in the lower animals, but not in the higher; most express themselves very decidedly that in the human species at least the male is the morphologically more perfect. It is a question of fundamental importance in any consideration of sexual dimorphism, especially in the valuation of the so-called secondary sexual characters. And should the common view be disproved, the relations of the sexes would show in a very different light; the male must be regarded as the inferior organism.

[1] Contributions from the Zoological Labratory of the University of Texas, No. 62.

The object of the present contribution is to deal with the subject briefly from the anatomical and embryological standpoint; considering first the Invertebrates, and lastly the Vertebrates.

1. The Invertebrate Animals.

Lamarck's collective group of the "*Invertebrata*" is of course retained to-day only for convenience; the numerous phyla which compose it differ far more greatly from each other than do any of the extremes of the *Vertebrata*.

In the *Invertebrata*, whenever there are marked structural differences between the sexes, it will be found to be a rule almost without exceptions that the male is morphologically inferior.

There are, in the first place, those numerous cases where the sexes are markedly different, in that one is much less developed than the other, *i.e.*, is the resultant of much shorter embryonic growth. Thus all the families of the *Rotatoria* so far as known, with the exception of the *Asplanchnidae* and *Seisonidae*, possess males inferior to the females in much smaller size and complete absence of the digestive system. As I expressed myself in a study of the *Flosculariidæ*, these males are arrested individuals. A more marked example is found in the Echiurid *Bonellia*, where the male is only one one-hundred-and-fiftieth the length of the female, and lacks an anal aperature; he is a degenerate, living as a parasite within the female. Similar examples occur in the *Cirripedia*. On the other hand it is seldom found that the female is embryologically more arrested than the male; such a case is that of the glowworm, however, where the male is winged but the female apterous, and in certain *Hemiptera heteroptera*. But these are arrests in external organs of locomotion, implicating less profound changes than those shown in the preceding cases.

Our case holds even for most hermaphrodites, paradoxical though it may at first appear to speak of males and females among hermaphrodites. In almost all examples of hermaphroditism it is the rule that the male and female organs of generation and reproductive cells do not mature simultaneously, but successively, as I have shown elsewhere.[1] In the greater number of these cases the male germ cells mature and are discharged first, then the female, a condition known as protandry. Here the individual is functionally

[1] "On Successive, Protandric and Proterogynic Hermaphroditism," *Amer. Nat.*, 1895.

first male, then (for a limited period) hermaphrodite (functionally male and female), lastly female; but since there is the same cycle of reproductive conditions in each individual of the species, the individual as a whole is ranked as hermaphrodite. This holds for some *Nemertini*, *Pelecypoda*, *Spongiaria*, most *Turbellaria*, *Myzostomida*, and for numerous other cases. These show the male condition to be established at the earlier ontogenetic period, before the individual has attained its complete growth; consequently the male condition is morphologically inferior to the female. There is, however, another state of hermaphroditism known as proterogyny (protogyny), with the female condition preceding the male. This is of course the reverse of protandry; it is very restricted in its occurrence, and is described only for certain pulmonate *Gasteropoda* and for the tunicate *Salpa*, cases that need reëxamination.

Hermaphroditism in the strict sense implies a condition of union of sexes in one individual, not an indifferent, non-sexual state. With this definition it is probable that hermaphroditism is a secondary condition wherever it is found, and not a primitive one. The earliest phyletic state is non-sexual, as in certain generations of some *Protozoa*. These are of anatomically distinct sexual individuals, as shown in the sporulation generations of some *Protozoa* (with micro-gametes and macro-gametes), and in most of the *Metazoa*. While hermaphroditism has appeared independently in different groups, such as the *Platodes*, the *Mollusca*, *Tunicata*, etc., where it occurs it is frequently the case that the more primitive members of the group are dicœcious (with separate sexes). No Protozoan can be correctly termed hermaphrodite, but sexual or non-sexual. *Volvox* cannot be considered either Protophyte or Protozoan, but Metaphyte or Metazoan, since it contains distinct germ cells and tissue cells; it accordingly is no exception.[1] But however the hermaphroditic state may be interpreted, it stands as an indubitable fact that in most hermaphrodites the male condition occurs during the less perfect stage of the individual.

In speaking of the male as being so frequently the more arrested, more embryonic individual, corroborative examples are found in

[1] It is indeed strange that *Volvox*, at this late date of our knowledge, should still be grouped with the *Protista*. The fundamental criterion of the *Metaphyta* and *Metazoa* is not number of cells, nor their specialization, but the possession of cells which are reproductive and other cells which are not. This is the only truly important physiological distinction.

the condition known as Neotenia. This term is applied when the germ cells mature before the tissue cells have attained their final specialization; the individual is mature sexually before it is corporeally. Neotenia is found mostly (whether always, I cannot say) in males. It is not infrequent, particularly among parasites; thus in the male Gordiacean the spermatozoa may be fully mature before the animal's external enticula is completely developed. This is but another case of the male condition, *i.e.*, the essentially masculine characteristic, appearing earlier, at a more embryonic stage, than the female state appears. An increasing acceleration (in the sense of Cope) of neotenia would throw the male condition further back into the ontogeny, and could lead to the formation of embryonic males, such as in the *Rotatoria*, etc.

There next comes up for consideration an array of forms where there are no well-marked secondary sexual differences, *i.e.*, differences apart from those furnished by the reproductive systems, and where the sexes are separate. These are found mostly in the lower *Invertebrata;* most *Nemertini* (but *Carinella* with distinct coloration of the sexes), most *Hydrozoa*, *Scyphomedusæ*, *Echinodermata*, *Enteropneusta*, most diœcious *Mollusca* and *Annelida*. Absence of secondary sexual differences is here correlated with aquatic life, fertilization of the germ cells without copulation, and relative simplicity of the genitalia. The latter in each sex consists of gonads, regions of localization of the germ cells known as testes and ovaries, and comparatively simple efferent ducts (or no preformed ducts). Accordingly, the testes and ovaries may be essentially alike, as simple sacs in the *Hydrozoa* and *Nemertini*, or surfaces in the *Polychæta*. When this is the case, and in the absence of secondary sexual differences, we cannot say which sex is morphologically the more advanced; but there is no evidence that the male is the superior. In the diœcious *Mollusca* the reproductive organs of the female are the more complex, in the presence of various glands concerned with the formation of egg envelopes, so that in these forms the female is the more perfect.

In the large groups of *Nematoda*, *Gordiacea*, *Crustacea*, *Arachnida*, *Insecta*, progoniate and opisthogoniate *Myriapoda*, there are generally present secondary sexual differences as well as differences in the genitalia. In the *Gordiacea* the male is smaller than the female, and sometimes with greater specialization of the cuticular protuberances; but the female has more complex reproductive

organs—glandular organs not present in the male, ovaries with lateral diverticula, while the testes are simple tubes. Among the diœcious *Nematoda* the male is always the smaller, with copulatory spicules and a bursa not represented in the female; also the testes are usually impaired, a higher condition, *i.e.*, one involving more modification, than the condition in the female where there are paired ovaries. On the other hand the female is larger, with the genital ducts more complicated and with a receptaculum seminis; and unlike the simpler male condition where the genital ducts open into a cloaca, the female shows the higher morphological state of a separate aperture for the reproductive ducts (with the single exception of *Cloacina*). In both these groups, then, the female appears structurally more advanced. In the group of *Insecta*, *Arachnida*, *Crustacea*, *Opisthogoneata* and *Progoneata* we find forms that in many respects appear the most specialized of all the Invertebrates (not excluding the *Tunicata*). They are all essentially terrestrial forms, for there is good reason to conclude with Simroth[1] that even the *Crustacea* arose from ancestors that lived upon the land, or at least in very shallow water, though most of the modern representatives are aquatic. In these annulate groups, contrary to the groups considered in the preceding paragraph, we find the association of terrestrial life necessitated thereby an intimate copulation process and notable differences in the reproductive organs, also secondary sexual differences. In these forms the male is almost always smaller than the female, notably so in many *Araneæ* (particularly of the family *Argiopidæ*). The only exceptions to this rule that occur to me are a few beetles and certain *Hymenoptera*. The male may be more complex than the female in the possession of clasping organs, and sometimes in the more complete development of sensory organs. So in the ants and flies particularly the compound eyes are frequently larger in the males, and sometimes differ from those of the female in being confluent (a secondary condition). The most important olfactory and tactile organs of Insects, the antennæ, are frequently larger and more complex in the males, as shown especially in the case of the Moths; and in the Spiders the special tactile organs, long hairs, are in some cases relatively and even absolutely larger in the males. Then it is well known that in these forms the male differs frequently in external form, and often is more brightly colored than the

[1] *Die Entstehung der Landtiere.* Leipzig, 1889.

female—frequently a morphological character, as in the case of all metallic, non-pigmental colors. In these groups then the male may be the morphological superior in the possession of clasping organs or greater development of sensory organs, or of external modifications of form and structural coloration.

But we must recollect that special clasping organs are not general; they are found mainly among the *Crustacea*, by no means in all of them, and usually in correlation with the lack of an intromittent organ. With the development of an intromittent organ, which attains the greatest complexity among all animals in the Insects and Spiders, special clasping organs are rarely found. When they exist they are for the most part comparatively simple modifications of already existing structures, usually limbs. Accordingly the possession of clasping organs is a character of little morphological import.

In regard to the point that the males of these groups are sometimes superior in sensory equipment, every comparative anatomist realizes that sense organs are of little morphological value, because they are not conservative and are readily changed or lost. The Medusæ have more complex sensory organs than, *e.g.*, the *Turbellaria*, but no one would rank the former higher on this account. Any change of life leading toward loss of locomotion, as in sedentary and parasitic animals, is followed by degeneration of the sense organs as one of the first modifications; and in the case of subterranean and cavernicolous species, such a comparatively slight change as that from light to darkness, induces the replacement of visual organs by tactile and olfactory. Notice the loss of the lateral line system of sense organs in the case of the emergence of aquatic Vertebrates from the water to the land; or at least, according to a recent theory, their change into non-sensory hairs. That greater size of sense organs by no means induces greater complexity of the nervous system is shown by the comparison made by Forel:[1] in the male ant (*Lasius*) the compound eyes are largest but the cerebrum (supra-œsophagial ganglion) most rudimentary, while in the female (particularly the worker) the eyes are smallest but the cerebrum with the greatest number of ganglion cells. In fact we may say, in the light of phylogeny, that greater size and complexity of peripheral sense organs is a more primitive condition than that of small and less complex sense organs but more concentrated

[1] *Ants and Some Other Insects.* Translated by Wheeler, Chicago, 1904.

nervous system. Phylogenetically the peripheral nervous system, composed essentially of sensory nervous units, is the earlier, more primitive condition; while the centralized reflex-mechanism is later and morphologically higher. First the simple surface sensory apparatus, later the internal coördinating centre. As the central nervous system becomes more complex, a process denoting morphological advance, the more complex sense organs are apt to disappear or to be replaced by more numerous ones of less complexity.

It follows from these considerations for the arthropodous groups, that though in a few cases the males may be equipped with sense organs of larger size, this character by no means implies structural superiority, and especially not when it can be shown that with it is associated a less complex central nervous system. Indeed in the ant the male is decidedly inferior, with regard to the nervous system as a whole.

The other secondary differences, as those of external form and coloration, are generally to the credit of the male. But it is obvious that such characters, from their very lack of conservatism, imply little structural value.

Now let us examine in these groups of *Nematoda*, *Gordiacea*, *Crustacea*, *Insecta*, *Arachnida* and *Myriapoda*, to which might be added a number of smaller groups such as the *Acanthocephala*, the points in which the female is the superior of the male. One has been mentioned, the presence in some Insects of a better developed cerebrum. The other point is the greater complexity of the reproductive organs. As homologous in the sexes we consider ovary with testis, oviduct with vas deferens, certain mucous glands, and in some cases vagina with intromittent organ. The male usually possesses as dilations of the vasa efferentia seminal vesicles; except for these and the intromittent organ he has no structures not represented also in the female. The intromittent organ may be very complex as in most Insects and in Spiders (terminal joint of the maxillary palpus), or it may be very rudimentary and simple. Where it is complex the vagina of the female is frequently as correspondingly complex (*Diptera*, *Coleoptera*). On this account the intromittent organ cannot be regarded in all cases as evidencing greater complexity in the male; and probably when systematic entomologists employ characters of the external female apparatus as extensively as they have done the male for purposes of diagnosis, they will find the receptive apparatus of the female to be quite as

complex in many cases. Whenever there is intra-parental development the oviducts become specialized in a portion of their extent as uteri; such structures are not represented in the male. Very frequently also there are special glands for the elaboration of egg envelopes. Very generally there is in the female a more or less complex receptaculum seminis, usually with its peculiar musculature and duct, which is not found in the male. The ovaries may have the same structure as the testes. But not infrequently the ovaries are more complex than the testes, and this is shown particularly in the arthropodous forms. This follows from the necessity of the production of yolk substance for the egg cells, substance to be stored up in the egg for the nourishment of the embryo, whereas such substance is used by the sperm cells only in limited amount. The first formation of the yolk substance is an elaboration by the vitellocytes (nurse or follicle cells), which are germ cells that have lost their reproductive ability and become nutritive. These have their representatives in the testes in the cells of Sertoli, also nutritive. But the ovarian vitellocytes play a greater part in the growth of the embryo, and accordingly they are larger or more numerous. Further they are segregated to form particular chambers of the ovary, so that the nutritive and reproductive cells occupy different places within the ovary. This is the case in the *Rotatoria* and some *Crustacea* (*Branchiopoda*), and in the Insects, where the egg-tubes that compose each ovary have each a terminal chamber of vitellocytes (*Hemiptera*), or vitellocyte chambers alternating with egg-cell chambers (*Coleoptera*). These are all specializations in the arrangement of the nurse cells which mark the ovary as being a more complex structure than the testis. Then there is found in the female of many Insects an apparatus for oviposition, known as the sting or ovipositor, often of high degree of complication, involving parts of two (or more?) segments; this is entirely absent in the male. The female usually guards and protects the young, sometimes with the development of a brood chamber (some *Crustacea*); that is only exceptionally the case with the male, and sometimes, as in the hemipteron *Zaitha*, he is forced by the female to carry the eggs against his will. But the males of the *Pycnogonida* carry the young.

From this rapid survey of some of the facts of sexual dimorphism, we find the supposed excellence of the male to consist in what are mainly unimportant morphological characters, of which the (not

universal) possession of an intromittent organ is perhaps of the most weight. Beyond this the male may possess clasping organs, in a few cases have larger sense organs, and show brighter or more contrasted coloration, and sometimes be more varied in external form. This is all he has to show in the claim of superiority. While the female possesses an internal reproductive apparatus which is generally of much greater complexity than that of the male, and sometimes a central nervous system of higher specialization, a condition which probably will be found to be general in all those numerous cases where the female carries out the chief cares of maternal solicitude for the young. And almost without exception the female is larger than the male, a character of some structural value, because it implies, *ceteris paribus*, a longer or intenser process of embryonic development. When either of the sexes is rudimentary in comparison with the other, it is in almost all cases the male. All the facts point to the male being the more embryonic and less developed, and none to his being the morphologically more progressive.

Physiologically, also, the female appears the superior in most of the Invertebrates. The male Rotatorian, as I have watched him, emerges from an egg much smaller than that which produces a female, lives a day or two without feeding for the good reason that he has no digestive organs, then dies; while the much larger and more complicated female lives for months. In Insects and Spiders the male seems to be always shorter-lived than his mate, generally takes no part in the care of the young and dies immediately after impregnating the female. But the female lives on after impregnation, sometimes for months before depositing the eggs; then oviposits, often after great care for the protection of the young; not until all this is accomplished does she die. We may say that the female develops more slowly, reaches a larger size and lives longer, and this, together with her care for the progeny, classes her as the distinctly important individual in the economy of Nature.

2. The Vertebrate Animals.

When we turn to the Vertebrates the comparison of the sexes becomes more difficult, especially in the higher forms. The primary sexual characters may be considered first, then the secondary.

In the matter of the reproductive organs there is a complicated series of facts of structure, which have not yet received adequate

consideration with regard to the relative morphological status of the sexes, nor yet with reference to their bearing upon the questions of phyletic relationship. Relative simplicty and similarity of the genital organs, as in the Invertebrates, is found only in aquatic forms, and in those where there is neither intimate union of the sexes nor intra-uterine development. This condition is realized in most Fishes, *Dipnoi* and *Batrachia*.

Among the Fishes, more especially the *Teleostomi* (*Ganoidei* and *Teleostei*), the testes and ovaries are much alike in structure, usually sacs with more or less folded walls; this is also the condition in the *Acrania* (*Amphioxus*). In the *Batrachia*, particularly the *Urodelia*, the testes are more complicated than the ovaries since they are divided into lobes. In the *Sauropsida* and *Mammalia* the ovaries are no longer sacs, but solid cellular masses with follicle cells and germ cells intermingled; there is always, however, more or less of a radiate lobulation of the organ. The testes of the same forms are composed each of masses of tubules, of which the walls are made of cells of Sertoli and early generations of spermatogonia, while their lumen becomes filled with more mature germ cells. There can be no question that in the higher Vertebrates the testes are more complicated than the ovaries, the reverse of the case in the Invertebrates. But while the testis is morphologically more complex, it nevertheless retains primitive embryonic structures more than does the ovary. For the vasa afferentia, namely, of the testis, as at least the proximal portions of the vasa efferentia (these together constituting the tubules of the testis), represent persistent mesonephric tubules, the second kidney system of the embryo; these persist in only very rudimentary form in the ovary. From this standpoint the testis, while more complex, is concurrently less progressive; the ovary, though structurally simpler, has changed more in the course of the ontogeny.[1]

The gonads are primarily paired in the Vertebrates, except in the *Cyclostomata*. When in higher forms there is degeneration of one of the pair it is always an ovary, as in Birds, and never a

[1] In regard to the comparison of the testis and ovary, it becomes obvious that greater complexity of structure, or specialization, does not imply greater morphological advancement of its possessor, unless it is associated with correspondingly greater change in the ontogeny. So an extreme parasite, as *Tænia*, is structurally simpler than its free-living ancestor, though in point of phyletic change it is far more advanced. Regressive development is still development. This is an important consideration which anatomists do not always appreciate.

testis. Reduction of one member of a structural pair is always a departure from the primitive condition, hence a more advanced morphological state than retention of both members. But with the case in point this morphological difference cannot be justly thought of much value, for with the right ovary of Birds, as with one of the lungs of Snakes, the reduction is due simply to mechanical pressure inducing stoppage of the nutritive blood fluid, and not to any profound change in the growth processes.

Turning to the comparison of the genital ducts, we find the most primitive condition in the *Cyclostomata*, certain *Teleostei*, and, according to Gegenbaur, in the Selachian *Læmargus:* there are no genital ducts, but the germ cells fall directly into the body cavity (coelom), and are discharged to the exterior through abdominal pores. In the *Acrania* there are also no ducts, but the relations are less simple in that the genital products fall into the atrium (an ectodermic cavity) and from there are passed to the exterior through the atriopore. In these forms the sexes are alike in the mode of discharge of the genital products.

In all other Vertebrates there are special genital ducts, which may be considered separately for each sex.

Four kinds of genital ducts may be distinguished in the male, according to their mode of embryonic formation. (1) The segmental duct (pronephric duct, duct of the earliest kidney system, the pronephros) persists as the urogenital duct, as the common duct of testes and kidneys. This is the most usual condition, and is found in all the *Amniota* (Reptiles, Birds, Mammals) and *Batrachia*, all the *Selachii* except *Læmargus*, in *Lepidosteus* and *Acipenser*. In all these cases a Müllerian duct is laid down, but either remains embryonic or disappears more or less completely. (2) A direct backward growth of the testis itself is the genital duct: most *Teleostei*. (3) An open groove of the peritoneum serves as a genital duct: *Polypterus* and *Amia*, according to the description by Jungersen.[1] (4) In *Protopterus* a tube formed within the testis is the sperm-duct, and this unites with the persisting posterior end of what is considered a Müllerian duct.[2] Of these kind of ducts the last three are much more alike among themselves than is any of them to the first kind. It follows that for all gnathostomatous Vertebrates, except some *Teleostomi Læmargus* and *Protopterus*,

[1] *Zoolog. Anzeiger*, 1900.

[2] According to the account by W. N. Parker.

there is in the male a common urogenital duct, the segmental duct, which is a duct persisting from a very early stage of the embryo.

In the female of gnathostomatous Vertebrates but two kinds of genital ducts are found. (1) The oviduct is a direct backward growth of the ovary: *Lepidosteus* and most *Teleostei*. (2) The oviduct is a Müllerian duct, separate from the ovary and from the segmental duct. This may arise as an off-splitting from the ventral side of the segmental duct (most *Selachii*), but it more usually develops independently of the latter as a fold or ingrowth of the peritoneal epithelium (*Batrachia*, *Amniota* and possibly *Dipnoi*). In the female there is accordingly never a urogenital duct, but the oviducts are separate from the ureters. Further than this, while the vas deferens of the male usually possesses dilations in the form of seminal vesicles, also a prostrate gland, the oviducts are much more specialized whenever there is intra-parental development of the young. For the oviducts, besides the possession of special glands, have very complicated dilations, the uteri, much more specialized than the seminal vesicles; and in most of the Mammals the oviducts are fused for a great portion of their extent, so that in the place of paired uteri there is but a single one—a further advance beyond the male condition. The uterus is not only a receptacle for the young, but a complicated nourishing apparatus, with recurring profound morphological changes. Even in some *Teleostei* (*e.g.*, *Zoarces*) uteri may be present, though most species of this group are oviparous. The complications of the female reproductive ducts are induced by viviparity.

From this comparison of the ducts of the reproductive organs, it follows that in respect to these structures the female is morphologically the more advanced. The most important fact is the embryological one that in the male there is generally a persisting urogenital duct, in the female never a urogenital duct but oviducts separate from the ureters.

With regard to other differences in the sexual organs, the most important is the relative position in the body of ovaries and testes. Both arise in gnathostomatous Vertebrates as parallel longitudinal ridges of the peritoneum, close to the dorsal mesentery. Of these ridges only a portion fully develops, the remainder becomes arrested. An ovary is a growth at about the middle of such a ridge, a testis at a point of the ridge somewhat further back. Both ovaries and testes retain their abdominal position in most Verte-

brates. But in the higher Mammals the testes move from this position (*descensus testiculorum*), at least periodically (*Rodentia*), into an external sac, the scrotum; morphologically speaking they are still, however, intra-peritoneal. This is of course a change without parallel in the female. But in those forms where this condition obtains the female shows a structural advance which quite balances the *descensus testiculorum*, namely, complex mammary glands. These are groups of enlarged cutaneous glands, usually with complicated ducts of discharge; in the male they do not advance beyond the embryonic condition and are rarely functional. The intromittent organ of the male attains its greatest complexity in certain *Teleostei*, *Reptilia* and the higher *Mammalia*, and then is always more complex than its female homologue, the clitoris. But in the Vertebrates it is never as complex a structure as in Insects and some Mollusks, and is hardly to be considered more specialized than the clitoris and vulva considered together. Special clasping organs of the male are infrequent (*Selachii*, *Anura*). The female, on the other hand, has in some cases brood chambers for the carriage of the young, as the pouch in the Marsupial Mammals and the skin of the back in the toad *Pipa;* the mouth cavity is of use in the Viper for protection of the young. It is more rare for the male to care for the young, and to have special structures for this purpose, but such cases are found in the abdominal pouch of the teleostean *Sygnathidæ* and the oral cavity of certain *Anura*.

The foregoing facts show that the genitalia of the male and female are essentially alike in the *Acrania* and *Cyclostomata*. In most *Teleostei* they are also alike, except that the male sometimes possesses an intromittent organ. But in most higher forms they are markedly dissimilar, and we can conclude that as a rule the female is morphologically more advanced in the point of gonads, genital ducts, and apparatus for the protection or nursing of the young. From the standpoint of the reproductive organs the female is clearly the superior.

Most investigators of mammalian embryology explicitly hold that the male represents an individual advanced beyond the condition of the female. They adduce the facts that the external genitalia are at first alike in the sexes, then while the clitoris remains small the intromittent organ continues to grow, and while the ovaries retain their original position the testes descend into the scrotum. But these are relatively small differences in comparison with the others we have reviewed.

The other characters in which the males of Vertebrates differ from the females are secondary sexual. Sometimes such external differences are very slight or not perceptible, as in many of the Fishes, Birds and urodelous *Batrachia*. In most of the group, as we found for the Invertebrates also, the male is smaller; this is the case in the *Acrania*, *Cyclostomata*, *Selachii*, most *Teleostomi*, *Dipnoi*, most *Batrachia*, even in most *Reptilia*. In most Birds where there are sexual differences in size the male is the larger (but the female is in certain species of *Falconidæ* and *Scolopacidæ*), and in Mammals too the male is generally larger. This is an important difference, particularly when it implies a longer growth period and slower attainment of maturity, as in the Primates; we shall recur to this point. When there occurs dichromatism, it is the male that has the brighter or the more contrasted colors, as it s the male that possesses more marked integumentary structures, such as odoriferous glands, combs, plumes, greater development of feathers and hair, spurs, etc. But the greater intensity of coloration does not always denote morphological advance, for frequently the colors are not structural (diffractive) ones. And the greater complexity or size of integumentary structures is well known to be a character of little morphological importance, because of the lack of conservatism of such parts, their ready susceptibility to change. Among closely related forms, as in some families of Birds, we may find a species in which the sexes are externally alike in color and plumage, and another species in which they are quite dissimilar in these respects. In the Reindeer the cow has antlers as well as the bull, contrary to the condition in other deer. It is only rarely that the differences of the male are of greater morphological import, as in the different form of skull in the male salmon. We may decide from another point of view that secondary sexual characters must be estimated as of little value, because they have not even the worth of a species diagnostic, being not representative of all the individuals of a species. Accordingly, such secondary sexual differences are of too small worth to occupy much attention in the matter of comparing the sexes.

We have now briefly compared the sexes by the standards of the structure of the reproductive organs and of the secondary sexual differences. We have found that while the female usually shows more advancement in the reproductive organs, the male evinces more in secondary sexual characters. Obviously it becomes a question of which of these characters is the more important.

The only secondary sexual character of morphological importance is that of bodily size, as we found in discussing the Invertebrates; it is the only one at all commensurate with anatomical differences in the genitalia. Its importance lies in the fact that greater size of one sex means a longer or more intense growth, greater continuation of development. This is the more evident where greater size is associated with longer time before the attainment of reproductive maturity. To be sure this must not be interpreted to mean that longer embryonic growth period is always to be construed as implying higher morphological rank, for the Elephant takes longer to mature than does Man, yet the Elephant is decidedly lower in the phyletic scale; so, also, some Reptiles take a longer time than many Mammals. But within the same species, where one sex grows larger than the other it is, *ceteris paribus*, a sign of distinct morphological advance beyond the other.

Now in most of the lower Vertebrates (most Anniotes and Reptilia) the female is the larger, and at the same time usually the more advanced with regard to the reproductive organs; the male shows his superiority only in unimportant integumentary characters. For such Vertebrates it is very plain that the female is structurally superior. But in most Birds and Mammals (much more rarely in lower forms), while the female is still more advanced in the structure of the genital organs, the male is usually the larger—a condition rare among animal groups treated as a whole. Is then the female still morphologically superior in these forms, or are we to consider that the relation has reversed itself so that in the highest forms the male has become the morphological superior? It is the question of the relative worth of the two characters: greater complication or embryological advancement of the reproductive organs or greater bodily size implying a longer period of development. Or we may state it: the female is embryologically the superior in respect to the reproductive organs, the male in regard to the other organs of the body—which of course is directly correlated with the greater part that the female takes in the process of procreation. While different morphologists might estimate the value of these characters differently, I am inclined to judge the greater embryological advancement of the reproductive organs to be a condition of more morphological importance than greater bodily size.

So we reach the conclusion, that the female is clearly the super-

ior, from the standpoint of morphological advancement, in the Invertebrates and the Lower Vertebrates; and still superior, but in less degree, in the higher Vertebrates. This is certainly the opposite of the view of most naturalists, but to my mind there can be no other inference from the facts.

University of Texas, September 22, 1904.

Stated Meeting, October 21, 1904.

President SMITH in the Chair.

The death was announced, at Philadelphia, of Rev. Jesse Y. Burk, on October 18, aet. 64.

Dr. George T. Moore, of the Department of Agriculture, Washington, read a paper on "A New Method for the Purification of Water Supplies."

Stated Meeting, November 4, 1904.

President SMITH in the Chair.

The death was announced of the Marquis de Nadaillac, at Château de Rougemont, St. Jean Froidmentel (Loir-et-Cher), on October 1, 1904, aet. 87.

The following papers were read:

"The Behavior of the Lowest Organisms," by Dr. Herbert S. Jennings.

"Electrolytic Calcium," by Joseph H. Goodwin.

Stated Meeting, November 18, 1904.

President SMITH in the Chair.

The death was announced, at Bethlehem, Pa., on November 16, of Dr. Thomas M. Drown, aet. 62.

Prof. Bailey Willis, of the Carnegie Institution, read a paper entitled "By Courtesy through China."